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Original article

Adverse effects as a consequence of being the subject of orthopaedic manual therapy training, a worldwide retrospective survey

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ABSTRACT

Background: Physical therapists (PTs) use a range of manual therapy techniques developed to an advanced level through postgraduate orthopaedic manipulative physical therapy (OMPT) programmes. The aim of this study was to describe the adverse effects experienced by students after having techniques performed on them as part of their OMPT training.
Design: A descriptive online survey of current students and recent graduates (≤5 years)m of OMPT programmes across the 22 Member Organisations of the International Federation of Orthopaedic Manipulative Physical Therapists.
Results: The questionnaire was completed by 1640 respondents across 22 countries (1263 graduates, 377 students. Some 60% of respondents reported never having experienced adverse effects during their manual therapy training. Of the 40% who did, 66.4% reported neck pain, 50.9% headache and 32% low back pain. Most reports of neck pain started after a manipulation and/or mobilisation, of which 53.4% lasted ≤24 h, 38.1% > 24 h but <3 months and 13.7% still experienced neck pain to date. A small percentage of respondents (3.3%) reported knowing of a fellow student experiencing a major adverse effect.
Conclusion: Mild to moderate adverse effects after practising manual therapy techniques are commonly reported, but usually resolve within 24 h. However, this survey has identified the reported occurrence of major adverse effects that warrant further investigation.

1. Background

Physical therapists use a range of manual therapy techniques including manipulation, mobilisation, neurodynamic techniques, and exercise as part of their patient management strategies (Gross et al, 2007, 2010; Hurwitz, 2012; Michaleff et al., 2012; Rubinstein et al., 2012).These techniques are first taught in entry-level educational programmes and developed to an advanced level through postgraduate programmes with specialisation in orthopaedic manipulative physical therapy (OMPT). Educational standards for postgraduate OMPT programmes are set and monitored by the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) across its 22 Member Organisations (countries). The IFOMPT Educational Standards provide a template for educational programmes in learning institutions internationally (Rusthon, 2016).

Learning and assessment of practical skills commonly involves students practising manual therapy techniques on healthy peers in an educational setting under both tutor supervision and student organised self-directed practice sessions. Practising, by definition, implies that techniques will not always be performed correctly, as students work to develop expertise within these skills (Descarreaux et al., 2006; Harvey et al., 2011; Knobe et al., 2012). Unlike many areas of medicine, OMPT is generally considered low risk, with few reported adverse effects (Carlesso et al., 2010a).

Although the definition of an adverse effect is focused on pharmaceuticals, any intervention could be substituted (WorldHealthOrganisation, 2009). The salient components of the

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definition are the reference to any untoward medical occurrence and the lack of a causal relationship. A Delphi consensus study (Carnes et al., 2010b) investigating adverse effects in manual therapy proposed a taxonomy using 'major', 'moderate' and 'minor' (Carlesso et al., 2010b).

- Major adverse effects were defined as lasting medium to long term, being moderate to severe, unacceptable, serious and distressing and normally requiring further treatment.
- Moderate adverse effects were defined identically, but being only moderate in severity.
- Minor adverse events were defined as short term and mild, non-serious, transient and easily reversible, requiring no further treatment or alteration of management strategy as the consequences are short term and contained.

Manipulation is a commonly used manual therapy technique to treat patients with spinal problems, specifically neck and low back pain (Bronfort et al., 2010; Gross et al., 2010). Manipulation is a passive, high velocity, low amplitude thrust applied to a joint complex within its anatomical limit (where active and passive motion occurs) with the intent to restore optimal motion, function, and/or to reduce pain (Mintken et al., 2008; Rusthon, 2016). Several guidelines support manipulation as a treatment of choice for a range of musculoskeletal dysfunction (Bronfort et al., 2010; Childs et al., 2008; Delitto et al., 2012; Gross et al., 2002; Group, 2003; Heijmans et al., 2003; Monticone et al., 2013).

Spinal manipulation, particularly when performed on the upper cervical spine, is associated with minor to moderate adverse effects in clinical populations (Carlesso et al., 2010b; Carnes et al., 2010a; Ernst, 2007; Rubinstein, 2008; Senstad et al., 1996). This has been has been a professional concern for some decades (Carlesso and Rivett, 2011; Carlesso, Gross, 2010b; Carlesso et al., 2013; Kerry et al., 2008; Taylor and Kerry, 2005). While the risk of major adverse effects with manipulation is low, 50–60% of manual therapy patients may experience minor to moderate adverse effects after treatment (Cagnie et al., 2004; Carlesso et al, 2010b; Carnes, Mars, 2010a; Ernst, 2007; Hurwitz et al., 2005; Paanalahti et al., 2014). Most of these effects disappear within the first 24–48 h after treatment (Cagnie et al., 2004; Paanalahti et al., 2014). A survey of 59 manual therapists in Belgium in 2004 reported headache (19.8%), stiffness (19.5%), local discomfort (15.2%), radiating discomfort (12.1%) and fatigue (12.1%) to be the most common minor to moderate adverse effects experienced by patients after cervical spinal manipulation (Cagnie et al., 2004). Major adverse effects, such as arterial dissection, myelopathy, vertebral disc extrusion and epidural hematoma, have been documented after chiropractic care (Gouveia et al., 2009; Malone et al., 2002; Rubinstein, 2008; Rubinstein et al., 2008; Senstad et al., 1996) and after manual therapy performed by physiotherapists (Carlesso, Gross, 2010b; Di Fabio, 1999; Sweeney and Doody, 2010).

Mechanistically, it is emerging that the most significant causal factors of adverse effects, particularly neurovascular effects, may not be the traditionally suspected speed and force of thrust characteristic of manipulation techniques, but rather the range and amount of movement itself (Bowler et al., 2011; Erhardt et al., 2015; Quesnele et al., 2014). Further, a theoretical model is developing whereby particular patient variables might be considered as risk factors for certain adverse effects. This is best exemplified by the detail within the IFOMPT cervical framework (Rushton et al., 2014). With these emerging considerations in mind, we were interested in investigating adverse effects related to a range of manual therapy techniques involving through-range movement, and not solely spinal manipulation. We were also interested in the relationships between having a history of musculoskeletal signs and symptoms and reported adverse effects.

Although, the reported rates of adverse effects related to manual therapy are low, they may have severe consequences if a major adverse effect. Existing data provide limited understanding of the precise extent and nature of the risks. Furthermore, no research has explored adverse effects during the learning of manual therapy techniques; and given that all OMPT students undergo such learning, this identifies a key gap in the literature.

2. Objectives

1] To describe any adverse effects experienced by OMPT students after having manual therapy techniques (manipulation, mobilisation, exercise, neurodynamic techniques) performed on them as part of their OMPT training.
2] To evaluate any long-term adverse effects (minor, moderate or major) experienced by this population in order to inform future educational OMPT strategy.

3. Methods

3.1. Design

A descriptive survey with questionnaires delivered online using Limesurvey® software.

3.2. Participants

Participants were either current OMPT students or recent graduates ($\leq$5 years since graduation) of OMPT programmes across the 22 IFOMPT Member Organisations (countries). Graduates $\leq$5 years were used to enable recall of effects and symptoms. To enable further accuracy of recall, questions were carefully selected by exploring frequency, location of pain, and activities affected by adverse effects (Dawson et al., 2002; Edwards et al., 2009).

3.3. Development of the questionnaire

Separate questionnaires were developed for the current students and graduates. The questionnaires were developed through questions retrieved from previous surveys investigating manipulative therapy practice in the cervical spine in IFOMPT member countries (Carlesso and Rivett, 2011), and the incidence and prevalence of side effects of spinal manipulation (Cagnie et al., 2004); and extended beyond manipulative techniques. Question selection was informed by an understanding of potential recollection bias, where patients show greatest accuracy for questions focused to location and frequency of pain and activities affecting pain, in contrast to discrepancies for questions on severity of pain (Dawson et al., 2002). The questionnaire consisted of a combination of closed and open questions, collecting data on the following areas of interest: respondent's background and experience including time spent practising mobilisations and manipulations both at a learning institution under supervision of a tutor and unsupervised in self-directed practice sessions with peers, previous existing complaints, any adverse effects experienced, description of adverse effect(s), and provision of information about potential adverse effects prior to experiencing techniques (Supplementary file 1).

In-line with Carlesso et al., major adverse effects were defined as either stroke or death or permanent neurological damage (Carlesso et al., 2010a). Minor or moderate adverse effects were defined as either headache, blurry vision, dizziness, radiating complaints in

the upper or lower extremity, fatigue or neck-, thoracic-, trunk pain or low back pain. Some questions were designed to provide insight into possible relationships between adverse effects and other factors, for example, "after which technique did the adverse effect(s) occur". The questionnaire was piloted on physical therapists (n = 5), showing the survey took 5–10 min to complete.

3.4. Recruitment

Recruitment of graduates was through the IFOMPT Member Organisation (country) delegate. An email explaining the objectives and details of the study was sent to all 22 delegates for forwarding to the graduate members of their national organisation to be completed within the following 3 weeks. The information included an embedded link to the graduate version of the questionnaire. Recruitment of current students was through the programme leaders of educational programmes. An email explaining the objectives and details of the study was sent to all programme leaders of the 65 IFOMPT approved learning institutions, asking them to forward the invitation with an embedded link for the student questionnaire to all of their current students.

Ensuring a good response rate to questionnaires is recognised as problematic, and to provide an incentive, entering participants into a prize draw was used (Cho et al., 2013). After one month, a reminder was send to the delegates and programme leaders, asking them to remind the potential respondents.

All IFOMPT delegates agreed to forward the information and invitation to participate to their individual members (graduates). IFOMPT represents (>16,900) individual members, but the majority will have graduated >5 years ago and would therefore be ineligible to complete the survey.

All but one programme leader agreed to forward the invitation to participate to all current students. The potential student numbers are unknown as most learning institutes will not release this type of information.

3.5. Ethical considerations

Participation in the survey was voluntary, and anonymity was assured as no personal data were stored by the web-based survey software, and personal data were separately stored from research data. Following the provision of study information and the opportunity for participants to ask any questions, consent was assumed by the participant deciding to complete the online questionnaire. The National Dutch Central Committee on Research Involving Human Subjects (CCMO) did not require review from a Medical Ethical Committee for this project.

3.6. Data analysis

Descriptive analysis (using frequency distributions and percentages) of demographic data (age, gender, home country of learning institute, years of experience, number of hours spent practicing manipulations) and adverse effects (number, type, duration, pre-existing complaints) for both graduates and students were used. A priori, we accounted for associations between risk factors for cervical arterial dysfunction and upper cervical instability as mentioned in the IFOMPT International Framework for Examination of the Cervical Region (Rushton et al., 2014) and manual therapy techniques. E.g. the association between upper cervical instability or hypermobility and upper cervical manipulation.

We tested if there were differences between graduates and students using Chi Square test in case of categorical data and an independent T-test in case of numerical data, using IBM SPSS Statistics for Windows, Version 23.0. Correlations between variables were assessed using the Spearman's rho, a correlation higher than 0.60 was considered as relevant (Portney, 2000).

4. Results

A total of 1640 respondents completed the survey (n = 1263 graduates and n = 377 students). Respondents represented all 22 IFOMPT countries, although the majority (n = 846; 67%) were from the Netherlands.

4.1. Demographic characteristics

Demographic characteristics of the participants are described in Table 1. Most students and graduates were in their thirties, but students were younger (mean difference of 5.4 years). Male and female gender were equally represented. The majority of graduates had completed their OMPT training in the Netherlands. Some respondents stated that they had studied in several countries; for these graduates, a combination of either Australia, the United States of America or the Netherlands and one other country was most often reported.

4.2. Pre-existing health complaints

4.2.1. Pre-existing risk factors

Most respondents (74%) reported none of the pre-existing risk factors (Table 2) prior to the start of their OMPT educational programme. However, fewer students (68%) reported having none of the risk factors compared to graduates (75%) ($p < 0.05$). For the 26% respondents who reported a pre-existing risk factor the highest frequencies were for "history of trauma" (7.3%), "smoking" (6.7%) and "migraine" (6.1%). With the exception of "past history of trauma to the cervical spine/vessels" ($p < 0.05$), there were no significant differences in any particular risk factor being present between students and graduates, nor with respect to the number of risk factors reported (# risk factors: 1 = 289 (17.6%), 2 = 102 (6.2%), 3 = 25 (1.5%) and 4 = 10 (0.6%)).

4.2.2. Pre-existing musculoskeletal complaints

Most respondents (60%) reported no musculoskeletal pain or problems prior to the start of their OMPT training (Table 3). More graduates (65%) than students (44%) reported no problems ($p < 0.05$). Cervical and lumbar spines were the regions where most problems were reported. In total, 18% reported that they had more than one region affected at any one time. A correlation was found between a history of pre-existing pain in the lumbar ($r_s = 0.67$) and cervical spine ($r_s = 0.66$) and having multiple painful regions. Only a small proportion of respondents reported themselves as hypermobile (29.5%); the majority were diagnosed by an OMPT teacher or a fellow student, and a very small proportion diagnosed by a different healthcare professional.

5. Educational programmes

Most respondents (51.3%) visited their learning institution 3–5 times per month. 23% visited their learning institution <2 times per month and 13.6% 6–10 times per month. Most respondents reported either 4–5 (39.6%) or 2–3 (37.6%) hours per day were used for supervised practical sessions. In addition, most students (50.6%) practised their skills with their peers for 2–3 h per day at their learning institution.

Respondents reported that the largest component of their OMPT programme was focused on mobilisations, followed by manipulations. Table 4 presents the time spent on manipulations,

Table 1
Description of the physical therapy respondents.

	Graduates (n = 1263)	Students (n = 377)
General characteristics		
Age (mean, SD)	37.5 (8.4)	32.2 (7.6)*
Gender (% male)	56%	49%*
Characteristics of OMPT training		
How many years ago did you start your OMPT training (mean, SD)	7.7 (3.9)	4.1 (3.8)
	7 (1–15)	2 (0–15)
How many years ago did you finish your OMPT training	4.6 (3.0)	n/a
	4 (1–10)	
How long did it take you to finish your training (median, min-max)	3 (0–14)	n/a
In which of the following countries have you followed your OMPT training		
Australia	24 (1.9%)	15 (4.0%)
Austria	n/a	16 (4.2%)
Belgium	26 (2.1%)	7 (1.9%)
Canada	56 (4.4%)	58 (15.4%)
Denmark	24 (1.9%)	1 (0.3%)
Finland	27 (2.1%)	17 (4.5%)
Germany	3 (0.2%)	27 (7.2%)
Greece	1 (0.1%)	2 (0.5%)
Hong Kong	n/a	2 (0.5%)
Ireland	6 (0.5%)	n/a
Italy	36 (2.9%)	28 (7.4%)
Netherlands	814 (64.4%)	32 (8.5%)
New Zealand	4 (0.3%)	13 (3.4%)
Norway	9 (0.7%)	20 (5.3%)
Portugal	n/a	21 (5.6%)
South Africa	93 (7.3%)	19 (5.0%)
Spain	20 (1.6%)	n/a
Sweden	3 (0.2%)	11 (2.9%)
Switzerland	22 (1.7%)	15 (4.0%)
United Kingdom	6 (0.5%)	23 (6.1%)
United States of America	75 (5.9%)	29 (7.7%)
Multiple countries	14 (1.1%)	21 (5.6%)

n/a = no data available; * = Significant difference between students and graduates ($p < 0.05$).
A total of 142 therapists stated that they started their OMPT training in the same year as they finished their course, these therapists came from Australia (6), Belgium (2), Canada (4), Denmark (1), Finland (1), Ireland (1), Italy (4), Netherlands (54), New Zealand (1), South Africa (53), Spain (3), UK (1) and the USA (11). Therapists that were invited were all registered PTs, and none of the educational programmes takes less than one year.

Table 2
Presence of risk factors prior to starting OMPT programme.

Presence of risk factors (according to the IFOMPT cervical framework (Rushton et al., 2013)			
Risk factor	Total respondents n (%)	Graduates n (%)	Students n (%)
Past history of trauma to the cervical spine/vessels	80 (4.9%)	49 (3.9%)	31 (8.2%)*
A history of migraine	100 (6.1%)	70 (5.5%)	30 (8.0%)
Hypertension	31 (1.9%)	22 (1.7%)	9 (2.4%)
Hypercholesterol/hyperlipidemia	11 (0.7%)	8 (0.6%)	3 (0.8%)
Cardiac disease, vascular disease, previous cerebrovascular accident or transient ischaemic attack	10 (0.6%)	8 (0.6%)	2 (0.5%)
Diabetes mellitus	8 (0.5%)	5 (0.4%)	3 (0.8)
Blood clotting disorders/alterations in blood properties (anticoagulant therapy)	12 (0.7%)	12 (1%)	0 (0%)
Long term use of steroids	10 (0.6%)	7 (0.6%)	3 (0.8%)
History of smoking	110 (6.7%)	83 (6.6%)	27 (7.2%)
Recent infection	8 (0.5%)	6 (0.5%)	2 (0.5%)
Immediately post partum	8 (0.5%)	7 (0.6%)	1 (0.3%)
Trivial head or neck trauma	77 (4.7%)	56 (4.4%)	21 (5.6%)
Absence of plausible mechanical explanation for your symptoms	6 (0.4%)	5 (0.4%)	1 (0.3%)
History of trauma (e.g. whiplash, rugby neck injury)	119 (7.3%)	88 (7%)	31 (8.2%)
Throat infection	30 (1.8%)	20 (1.6%)	10 (2.7%)
Congenital collagenous compromise	5 (0.3%)	4 (0.3%)	1 (0.3%)
Inflammatory arthritides	8 (0.5%)	5 (0.4%)	3 (0.8%)
Recent neck/head/dental surgery	12 (0.7%)	8 (0.6%)	4 (1.1%)
Osteoporosis/osteopenia	13 (0.8%)	11 (0.9%)	2 (0.5%)
Structural instability	39 (2.4%)	26 (2.1%)	13 (3.4%)

* = Significant difference between graduates and students ($p < 0.05$).

mobilisations, exercise therapy and neurodynamic techniques throughout the entire programme/curriculum. A small percentage (3.4%, n = 56) of respondents reported that their programme did not include manipulation techniques; these respondents reported undertaking their educational programme in a range of countries: Australia (6), Austria (1), Canada (13), Finland (2), Germany (2), Ireland (1), Italy (1), Netherlands (21), Portugal (1), South Africa (4), Switzerland (1) and the USA (3).

Table 3
Musculoskeletal problems present prior to OMPT programme.

Signs and symptoms in any of the following regions			
Region, Most reported problem in this specific region	Total number of responders that reported prior problems in this region n (%)	Graduates reporting prior symptoms in this region n (%)	Students reporting prior symptoms in this region n (%)
Head, Mostly headache	93 (5.7)	66 (5.2)	27 (7.2)
		60 (4.8)	26 (6.9)
Cervical spine, Mostly pain	290 (17.7)	206 (16.3)	84 (22.3)*
		131 (10.4)	53 (14)
Thoracic spine. Mostly hypomobility	117 (7.1)	82 (6.5)	35 (9.3)
		71 (5.6)	26 (6.9)
Lumbar spine, Mostly pain	338 (20.6)	224 (17.7)	114 (30.2)*
		153 (12.1)	86 (22.8)
Pelvis, Mostly pain	57 (3.5)	27 (2.1)	20 (8.0)*
		20 (1.6)	24 (6.4)
Upper extremity, Mostly pain	105 (6.4)	65 (5.1)	40 (10.6)*
		39 (3.1)	20 (5.3)
Lower extremity, Mostly pain	137 (8.4)	80 (6.3)	57 (15.1)*
		51 (4)	37 (9.8)
Other	6 (0.4)	5 (0.4)	1 (0.3)

* = Significant difference ($p < 0.05$).

5.1. Examination prior to acting as a model for manipulation

Twenty six percent respondents reported that they had not received any form of examination (e.g. pre-manipulative testing protocol or assessment of the manipulative position or similar) prior to acting as a model for a tutor demonstration of a manipulative technique or being practised on by peers. The highest frequencies of respondents being from Sweden (50.0%), Denmark (40.0%), Norway (37.9%), and the Netherlands (32.6%). The lowest frequencies were reported for Australia (7.7%), Austria (12.5%), Canada (14.0%) and South Africa (13.4%). Most respondents (74.5%) reported that they had been asked in a general manner whether or not there were any risk factors, and/or had been physically examined prior to being a model. Most respondents were provided with information about potential adverse effects of manipulation before they were manipulated, with 13.8% reporting that they did not receive any information. Most respondents received verbal information and 17.3% were required to provide informed consent to act as a model. There were no significant differences between students and graduates regarding examination.

6. Adverse effects

6.1. Type of adverse effects

Most respondents (59.4% graduates, 58.1% students) reported never having experienced an adverse effect during their OMPT training. No significant differences between students and graduates were found. Of the students and graduates with a history of musculoskeletal complaints, 48.5% reported having experienced adverse effects during their OMPT training compared to 36.0% in those without a history. This difference was significant ($p < 0.05$).

Of the 672 (40.9%) of respondents that reported having experienced an adverse effect, 66.4% (446) experienced neck pain, 50.9% (342) headache and 32% (215) low back pain. Some adverse effects were reported infrequently by respondents: blurry vision (1%), radiating complaints in the upper extremity (2.9%) and lower extremity (2.9%), dizziness (6.0%), thoracic pain (7.6%) and fatigue (7.4%). In comparing the reporting of adverse effects between graduates and students, students reported significantly more radiating complaints in the lower and upper extremity than graduates ($p < 0.05$) but otherwise the data were similar.

Out of the students and graduates that reported they did not have any prior musculoskeletal complaints, 24.7% (244) reported adverse effects of neck pain, 18.8% (186) headache and 9.9% (98) low back pain following OMPT techniques, as opposed to 31.0% (202), 23.9% (156) and 17.9% (117) respectively, of those with a history of musculoskeletal pain.

6.2. Techniques used after which adverse effects occurred

Most respondents who reported neck pain as an adverse effect, stated it started after a manipulation and/or a mobilisation. Less than 6% of respondents reported neck pain following exercises or neurodynamic techniques. The reporting of headache and low back pain demonstrated the same distribution. Table 5 details the number and percentages of adverse effects reported after a specific technique.

6.3. Time interval between technique and adverse effect

For most respondents, adverse effects presented within half a day of having experienced a technique, irrespective of the technique used. If the adverse effect of neck pain followed a

Table 4
Distribution of time spent on topics within the entire educational program.

Part of the program	Manipulations	Mobilisations	Exercise	Neurodynamics
<1%	3.4%	1.5%	6.3%	6.8%
1-10%	16.3%	5.5%	51.2%	62.7%
11-20%	21.3%	18.0%	31.0%	25.3%
21-40%	39.9%	54.8%	11.2%	5.2%
41-60%	14.6%	16.0%	0.2%	0.1%
61-80%	4.0%	3.5%	0%	0%
81-100%	0.4%	0.5%	0%	0%

manipulative technique, 22.6% respondents reported it occurring after a few seconds, 39.4% < 10 min and 51.7% within 30 min. Only a very small percentage reported neck pain occurring after a day or more (8.6%). Less respondents reported neck pain occurring a few seconds after a mobilisation (12.1%) compared to a manipulation (22.6%) or a neurodynamic technique (25.0%). However, 32% reported it had taken less than 10 min after either a manipulation or a mobilisation, 47.4% stated it had occurred within 30 min and 89% had felt neck pain within half a day. Again a very small percentage reported neck pain had started after a day or more (3.3%).

Headache adverse effects usually started later than neck pain, as only about 10% reported that it had started in a few seconds no matter what technique was used, but almost all responders stated it had started within half a day and only <8% reported that it had started later than half a day.

6.4. Duration of adverse effects and technique used

Most respondents who experienced neck pain, reported it had only been for a short duration; either <24 h (53.4%), or >24 h but <3 months (38.1%). However, 13.7% of graduates reported still experiencing neck pain that they felt was related to their OMPT training. Most respondents reporting headache reported that it had resolved within 24 h (77%). However, 5.5% of graduates reported still experiencing (periodic) headaches that they felt was related to their OMPT training. Low back pain presented in the same pattern as neck pain with 44.2% respondents reporting that it resolved within 24 h and 42.8% reported its presence for >24 h but <3 months. However, 16.9% of graduates reported still experiencing recurrent low back pain that they felt was related to their OMPT training.

6.5. Longer lasting effects

Out of the 514 respondents that reported either temporary or longer lasting adverse effects, 111 (21.6%) reported still experiencing these the effects. None of these included blurry vision. Respondents that reported either blurry vision, dizziness or fatigue had the lowest rate of persisting complaints (0–3%). Of the 111 respondents that reported still having pain, 40.5% described chronic or recurrent neck pain, 12.6% headache and 17.1% low back pain that they felt was related to their OMPT training. Out of the students and graduates that reported they did not have any prior musculoskeletal complaints, 8.4% (55) reported still experiencing pain to date as opposed to 7.9% (78) of students and graduates with a history of musculoskeletal pain; the difference was not statistically significant.

6.6. Major adverse effects

There were no self-reports of non-fatal major adverse effect (e.g. stroke). A small percentage of respondents (3.3%) reported knowing of a fellow student experiencing a major adverse effect (stroke or death). The absolute number of major adverse effect events is not possible to quantify from these reports.

7. Discussion

This is the first study describing adverse effects experienced by PT students after having manual therapy techniques performed on them as part of their OMPT training. The findings demonstrate that the majority of students do not have any of the risk factors described in the IFOMPT cervical framework document (Rushton et al., 2014) The 40% of responders reporting adverse effects, is slightly more than the 33% of responders to a postal survey of Irish manual therapists reporting adverse effects in their patients in the past 2 years (Sweeney and Doody, 2010), but less than the 60.9% of patients reporting side effects in a Belgian study (Cagnie et al., 2004). However, what is notable is that 40.0% of respondents without a history of musculoskeletal pain, reported having experienced adverse effects; and that 21.6% of responders report still experiencing longer lasting effects, irrespective of having a history of musculoskeletal pain before the start of their OMPT training. Most reported effects were minor, and their descriptions and occurrences are consistent with previously reported minor adverse events in patient populations, e.g. Cagnie et al., 2004, Carlesso et al., 2010b (Cagnie et al., 2004; Carlesso, Gross, 2010b).

Recently, 2 cases of OMPT students both being at risk for an adverse effect have been described (Pool et al., 2016). Our data highlight that this is an important issue with a significantly lower percentage of current students, compared to graduates, reporting the presence of individual risk factors (described in the IFOMPT cervical framework document (Rushton et al., 2014)) and signs and symptoms prior to the start of their training. This may be due to an increased awareness of current students for the potential of adverse effects owing to the increasing body of knowledge and number of publication on this topic. In this context, it is interesting to note that nearly 26% of respondents reported that they had not received any form of examination prior to acting as a model for a tutor demonstration of a manipulative technique or being practised on by peers. Also, 13.8% of respondents did not receive any information about possible adverse effects of manipulations, before they acted as a model for a manipulation; with only a small number (n = 56) reporting manipulative techniques were not part of their curriculum. All adverse effects were present within half a day and the majority of respondents reported these had started after a manipulation and/or a mobilisation, irrespective of the technique used. Educational programmes would do well to make a note of this to tutors as well as students and the peers they practice with and edit their practical sessions accordingly.

The anecdotal reports from 3.3% of all responders knowing of a fellow student who had suffered a major adverse effect provide some insight in to the possible size of risk of this type of effect,

Table 5
Prevalence of adverse effects after a specific technique.

Technique	Manipulation n (%)	Mobilisation n (%)	Exercises n (%)	Neurodynamic n (%)	Other n (%)
Neck pain	399 (24.3)	190 (11.6)	13 (0.8)	24 (1.5)	9 (0.5)
Headache	295 (18.0)	177 (10.8)	14 (0.9)	15 (0.9)	5 (0.3)
Low back pain	171 (10.4)	114 (7.0)	13 (0.8)	18 (1.1)	2 (0.1)
Thoracic pain	105 (6.4)	47 (2.9)	6 (0.4)	5 (0.3)	2 (0.1)
Fatigue	96 (5.9)	70 (4.3)	22 (1.3)	15 (0.9)	2 (0.1)
Dizziness	81 (4.9)	39 (2.4)	1 (0.1)	1 (0.1)	2 (0.1)
Radiating complaints upper extremity	26 (1.6)	19 (1.2)	15 (0.9)	15 (0.9)	3 (0.2)
Radiating complaints Lower extremity	28 (1.7)	20 (1.2)	3 (0.2)	16 (1.0)	0
Blurry vision	15 (0.9)	3 (0.2)	0	0	0

Note: Some people reported multiple techniques in >1 affected region.

which would appear low. However, it is not possible to understand from these data whether or not individual responders were referring to the same cases or not. Further, the methodology used in this survey does not enable any guarantee of the accuracy of these reports. Therefore, the anecdotal reports are by no means an indication of prevalence of major adverse effect.

In the 40% of respondents reporting a history of a pre-existing musculoskeletal problem, the cervical and lumbar spine were the most common regions for adverse effects. These were also the regions where most adverse effects were reported for both students and graduates. This might be due to more time being spent on teaching and practising techniques in the spine compared to the extremities in OMPT programmes, but we have no data to analyse this.

7.1. Strengths and limitations

Collecting meaningful data on adverse effects is a challenging pursuit, especially when data from multiple and varied operations is required. This survey has begun a process of a further understanding of the consequences of teaching and learning OMPT practice. But to be able to confidently draw more conclusions, more high quality research is needed. The most significant limitation of this survey is that any relationships emerging from the data are not causal. The survey set out to describe and evaluate the nature and occurrence of effects, and as such the processes used were not intended to generate causal claims, nor indications of prevalence. Another limitation is the potential for recall bias. It has been shown that in general, patients are able to recall pain and impaired functioning that they reported 5 previously with fair to moderate agreement. Accuracy rises when a careful selection of questions is made. (Dawson et al., 2002; Edwards et al., 2009). But prior musculoskeletal symptoms are poorly remembered after some years, and the recall is strongly influenced by current symptoms (Miranda et al., 2006). This might have lead to under-reporting and an under-estimation.

Due to not receiving information on the denominator of responders numbers, there is no information about the response rate nor if respondents may differ to the non-respondents, which might potentially lead an over-estimation of adverse effects.

A large portion of the study sample was from the Netherlands, which traditionally has a large number of manual therapists. In comparison, there were not many respondents from other countries with a large number of programmes like the UK and USA. However, as all programmes are based on the IFOMPT Standards, there will be good consistency between them, perhaps negating the influence of participants' country of origin?

8. Conclusions

The objectives of this survey were to describe and evaluate adverse effects experienced by OMPT students during and after their training. This if the first such survey of adverse effects in OMPT student education. There are difficulties in collecting meaningful information on these types of events, and this survey offers a substantial starting point to understand the pattern of events, and also acts as a catalyst to consider what measures and strategies could be taken as a result of the findings. Mild to moderate adverse effects after practising manual therapy techniques are commonly reported by OMPT students with and without pre-existing musculoskeletal complaints, but usually resolve within 24 h. However, some effects persist for up to 5 years or more. The descriptions and occurrences of minor effects appear to be in line with similarly reported minor events in patient populations, and as such could be considered normal responses to these types of interventions.

There are a considerable number of people who act as models for OMPT practice who have risk factors for potential moderate and major adverse effects that are not explored prior to intervention. Those responders who reported pre-intervention screening were screened by a number of different methods, and many were in line with recent IFOMPT recommendations. The process of informed consent seems at best inconsistent. Furthermore, neither the background literature nor this survey revealed that there is in place any form of reporting mechanism for adverse effects. Whilst the occurrence of moderate to major adverse effects is believed to be low, it would be salutary to consider a robust and standardised reporting system for these levels of effects.

9. Key messages

- Minor, transient adverse responses to OMPT procedures are common.
- Moderate and major adverse responses seem uncommon, but a meaningful understanding of their true nature and prevalence is lacking.
- A screening tool, such as the IFOMPT framework for risk assessment, should be validated for use in educational settings and consistency of its used promoted.
- A consistent informed consent process should be developed with region-specific medico-legal legitimacy.
- A mechanism for reporting of moderate to major adverse effects should be developed.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.msksp.2017.02.009

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